EXPERIMENTS WITH ARTIFICIAL INTONATION CONTOURS

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In analysing perceptually Dutch pitch patterns, use is made of the Intonator,[1,2] the various applications of which are to be reported here. These can be viewed from three aspects, leading to experiments: a) in an effort to check hypotheses derived from previous analysis, b) involving a technique of analysis by synthesis to uncover new phenomena whose relevance, as well as the perceptual tolerances of already known patterns, are to be investigated, and c) calculated to afford insight into a speaker's assumed capacity, on the basis of a deliberate programme, to control the up and down movements in vocal pitch.

a) As for the "declination", the often observable gradual fall of pitch during an utterance, it was found to be generally applicable in tests in which short utterances (2—3 sec), processed through the Intonator, were presented to subjects. With utterances exceeding 5 sec, the rule controlling the slope had to be modified to provide for a levelling off towards the end, a result, later confirmed by the observation of a natural lower limit in recordings of voice pitch. The intuitive notion of dominance, used as a concept to determine the locations of rises and falls (constituting a "hat pattern"[2]), could be confirmed in a reading experiment in which subjects were asked to underline in a continuous text those words that, in their opinion, were dominant.

A systematic alternation of rises and falls, implied in the basic shape of the hat pattern, was found to allow for a more explicit formulation, viz. "what goes up must come down", thus precluding a succession of, e.g., two rises. However, in some cases a succession of falls was observed; use of the Intonator revealed, that in such cases the second fall was optional. Such a test with the Intonator in deciding which of the two semifalls is perceptually more relevant affords a typical example of the method of analysis by synthesis.

b) This very method was used to establish perceptual tolerances of locations in time of major features of the hat pattern. The values found could amount to as much

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[1] A. Cohen, J.'t Hart; Perceptual analysis of intonation patterns, *Proc.* 5th *ICA*, Liège, 1965.

[2] J.'t Hart; Perceptual Analysis of Dutch Intonation Features, *IPO Annual Progress Report* 1, 1966.

as 100 ms or more, unless an adjacent syllable would adopt spurious prominence, in which case a change of some 30 ms could bring about a drastic change in interpretation of the utterance.

Utterances containing odd numbers of dominant words will show a succession of rises, seemingly contradicting the rule mentioned above. To uphold the rule,

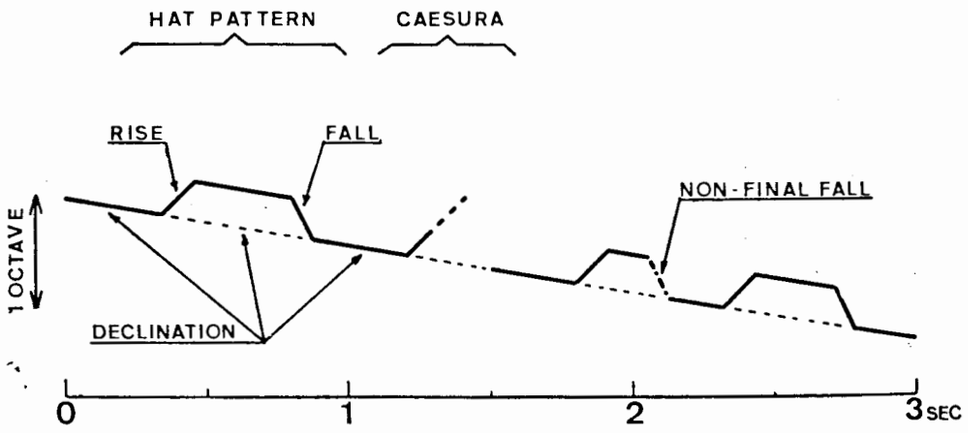

Fig. 1. Illustration of some of the most important features of Dutch intonation, in stylized form, and for an imaginary utterance.

a fall had to be introduced in between two rises, without causing any additional prominence. Such a "non-final" fall, devised on the basis of the model, and successfully tested for its perceptual relevance, proved to be helpful in unravelling the seemingly capricious up and down movements found in pitch recordings.

In a study of Dutch proverbs the notion of caesura (a sign of continuation between two hat patterns) could be verified by simulating pitch patterns to obtain best matches for naturalness with those of the spoken versions.[3] It was found, that it had to be considered more complex than originally assumed, and capable of influencing the preceding hat pattern. This anticipatory action involves either an omission of the final fall preceding the caesura, or its substitution by a rise, requiring the introduction of a non-final fall to obviate an otherwise forbidden succession of rises. Of the two main characteristics of a caesura, the upward wriggle has disappeared, whereas resumption of the pitch at a low level has been preserved. The modification of the caesura rules helped in analysing pitch curves while studying observed errors occurring under conditions of reading aloud, as will be dealt with under c).

c) Material, obtained from having subjects read aloud texts presented piecemeal and devoid of punctuation, provided errors of intonation. Such errors, which were

[3] J. F. Rijckaert, *IPO Rapport no.* 89 (In Dutch.).

detected on an intuitive basis, could be interpreted in terms of a possible disarray on the part of the speakers, confronted as they are with insufficient data on which to base an adequate control of up and down movements of voice pitch. Typical errors are inconsistencies in generating permissible variants of a caesura and executions of final falls on non-dominant terminal words of stretches that semantically require an ending. Similar errors can frequently be observed in the speech of newsreaders. Processing samples of these errors by means of the Intonator and based on rules implied in the model led to significant improvement.

Such a study of errors may help in getting a better insight into the mechanism underlying the correct programming of voice pitch, and reflecting in some way or another the syntactic structure in normal speech.